WVT-TR-76041

COMPUTED EXTREME TEMPERATURE RESPONSE OF MEDIUM CALIBER ANTI-ARMOR AUTOMATIC CANNON TEST BED NO. 2

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October 1976

U S ARMY ARMAMENT COMMAND

BENET WEAPONS LABORATORY
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TECHNICAL REPORT

AMCMS No. 662603.11.H7800

DA Project No. 1W662603AH78

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER
WVT-TR-76041

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle) Computed Extreme Temperature Response of Medium Caliber Anti-Armor Automatic Cannon Test Bed No. 2

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
P. M. Vottis

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Benet Weapons Laboratory
Watervliet Arsenal, Watervliet, NY 12189
SARWV-RD-SE

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
AMCMS No. 662603.11.H7800
DA Proj No. 1W662603AH78

11. CONTROLLING OFFICE NAME AND ADDRESS

12. REPORT DATE
October 1976

13. NUMBER OF PAGES
8

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Automatic Cannon
Temperature Sensitivity
Medium Caliber
Thermal Effects

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Extreme temperature behavior is computed for the Medium Caliber Anti-Armor Automatic Cannon Test Bed No. 2 being produced by Watervliet Arsenal. Computation of barrel recoil is of primary interest for operation in conventional recoil mode and receiver motion is most important in constant reaction recoil mode. Computations for operation at -65F and 145F show departure from 70F operation but no unacceptable variations occur.

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INTRODUCTION

This work has been performed under Project 1W662603AH78, Armament Area 4: Armored Vehicle Armament Technology. The Medium Caliber Anti-Armor Automatic Cannon program is producing several test bed automatic cannon for benchmark data generation purposes. Watervliet Arsenal is completing a 60mm unit designed to represent a compact mechanism capable of rapid fire of high velocity KE rounds, incorporating advanced features to minimize barrel erosion and barrel vibration. This unit is designated MC-AAAC Test Bed #2. The particulars of its structure are available in references 1 and 2.

Test Bed #2 has been designed for operation in two modes of recoil. It can be rapidly converted from Conventional Recoil Mode to Constant Reaction Recoil Mode and back. A program task has been to calculate the effect of temperature extremes on the operation of Test Bed #2.

METHOD

The primary effect of temperature on the gun/ammo subsystem is to alter the burning rate of the propellant. This, in turn, manifests itself as a variation in gun pressure, projectile velocity, and impulse delivered to the gun. The first consideration then is to determine the degree impulse varies with temperature.

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1. Dynamic Analysis of Constant Reaction Systems for a Medium Caliber Anti-Armor Automatic Cannon, P. M. Vottis, J. K. Jorczak, July 1976, Watervliet Arsenal, Watervliet, NY.

2. (C) Dynamic Analysis of a Medium Caliber Anti-Armor Automatic Cannon (U), J. K. Jorczak, July 1975, WVT-TR-75033, Watervliet Arsenal, Watervliet, NY.

The variation in impulse delivered to the gun by firing the round is taken directly from a similar ballistic case. The M68 gun firing the APDS round at 4850 fps and 58,500 psi with M30 propellant has the same propellant composition, is similar in velocity level, and somewhat lower in pressure. Reference 3 presents for the M68 the following velocity/temperature coefficients:

Range 70F to 125F: 3.13 fps/F

Range -40F to 70F: 2.41 fps/F

Using velocity variation coefficients to compute impulse variation requires the assumption that the portion of impulse delivered after shot ejection has the same variation with temperature as that delivered before shot ejection. We make this assumption and additionally extend the range of the coefficients by assuming they apply over the range -65F to 145F. The following table shows the resulting impulse variation:

TABLE I - VELOCITY AND IMPULSE VARIATION WITH TEMPERATURE

Temperature Change	Velocity Change	% Velocity Change	% of 70F Impulse
70F to 145F	+ 234 fps	4.82	104.8
70F to -65F	- 326 fps	-6.72	93.3

The above impulse variation factors are shown in Figure 1. They are used to vary the driving force functions in computer simulation programs for MC-AAAC Test Bed #2 operation in both the conventional recoil mode and in the constant reaction recoil mode. These computer programs are described in references 1 and 2.

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3. Summary of Pressure Differential Effects for Artillery Weapon Systems, H. B. Anderson, March 1966, Report No. DPS-1917, Aberdeen Proving Ground, MD.

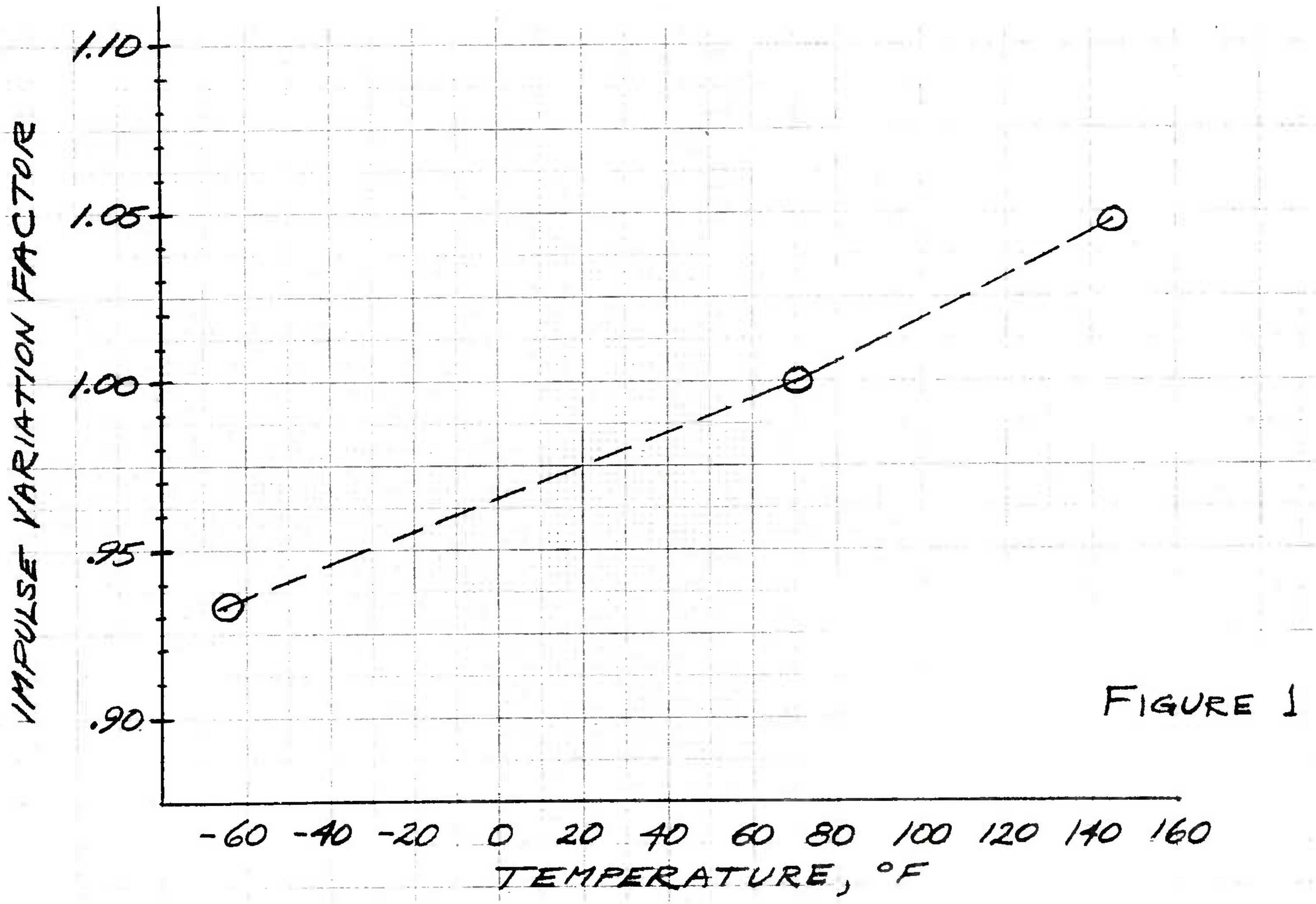

FIGURE 1. IMPULSE VARIATION FACTOR Vs TEMPERATURE

RESULTS

Table No. 2 shows items of primary interest in the conventional recoil mode. There is a slight variation in barrel recoil travel. The Test Bed is recoil operated, however, and variation in recoil travel affects the operation of the entire mechanism. The small variation in barrel motion is amplified by an attached accelerator whose function is to push the bolt carrier assembly away from the barrel and into a sear location. The velocity attained by the bolt carrier assembly is also given in Table 2. Its large variation is both expected and acceptable.

TABLE 2 - BEHAVIOR OF TEST BED #2 IN CONVENTIONAL RECOIL MODE

Temperature	% 70F Impulse	Barrel Recoil Distance	Carrier Velocity Into Sear
- 65F	93.3	14.19 in	112. in/sec
70F	100.	14.61	170.
145F	104.8	14.86	213.

Table 3 presents the performance of the Constant Reaction Mode option. Of interest is the maximum recoil distance of the receiver. This variable strongly affects the required structure in terms of permissible stroke, location of sears, degree of adjustability required, and location and action of final stop buffers. For a high temperature round the receiver recoils 1.64 inches further back than the initial latch point after the first round. Figure 2 shows the recoil on succeeding rounds. The sequence of maximum recoils portrayed shows the tendency to home-in on an equilibrium value. No trend to instability is indicated at any temperature.

TABLE 3 - BEHAVIOR OF TEST BED #2 IN CONSTANT FORCE RECOIL MODE

Temperature	-65F	70F	145F
% 70F Impulse	93.3	100.	104.8
Distance: Receiver latch to fire point	10.6 in	10.6	10.6
Round 1			
Receiver max recoil distance	7.97 in	10.6	12.24
Receiver velocity at firing next round	-50.2 in/sec	-57.	-60.85
Round 2			
Receiver max recoil distance	9.62 in	10.6	11.34
Receiver velocity at firing next round	-54.61	-57.	-58.86
Round 3			
Receiver max recoil distance	8.61	10.6	11.92
Receiver velocity at firing next round	-51.93	-57.	-60.14

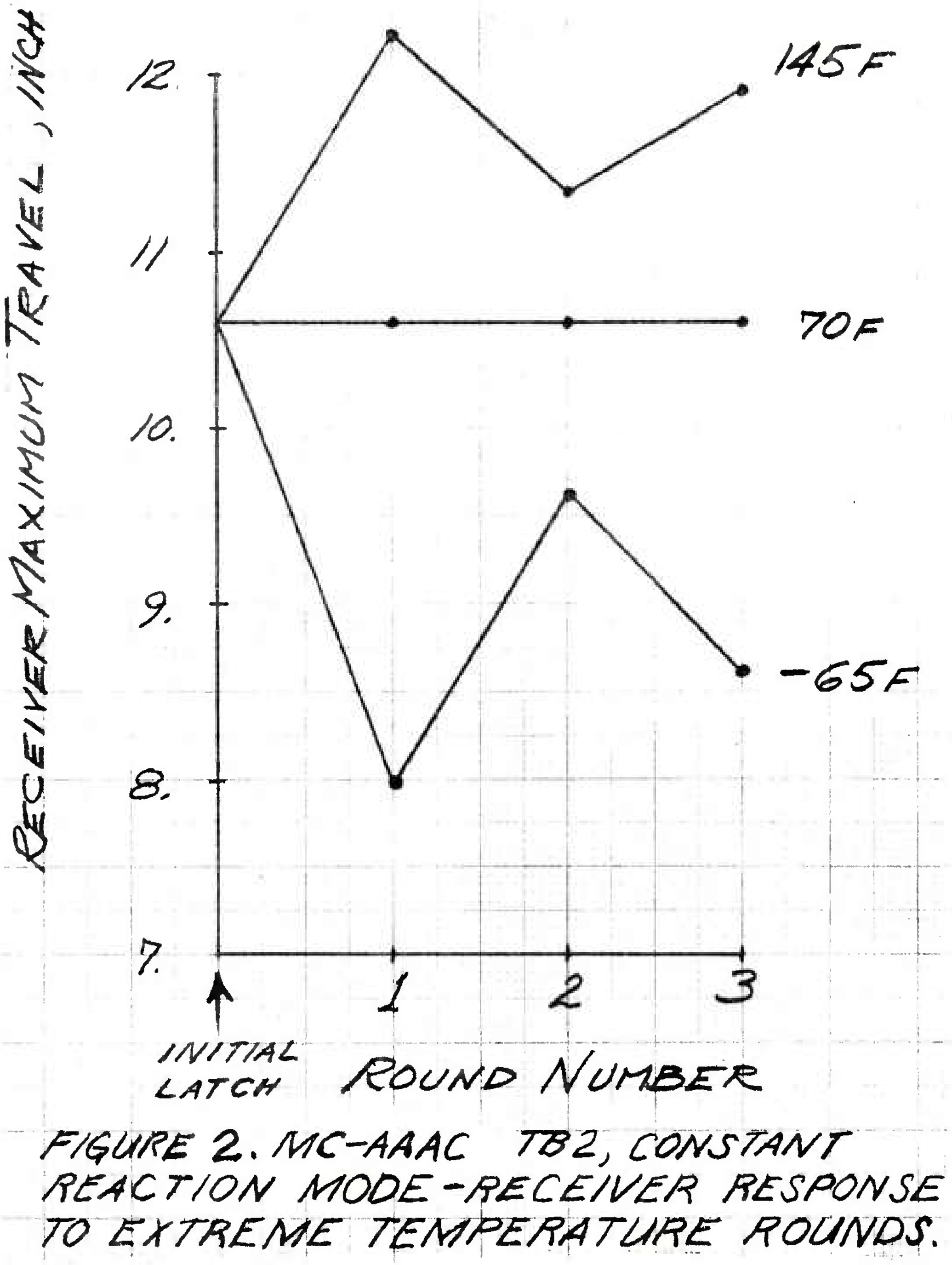

FIGURE 2. RECEIVER RESPONSE TO EXTREME TEMPERATURE ROUNDS

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